

## TED Lesson: There may be extraterrestrial in our solar system

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Deep in our solar system, a new era of space exploration is unfolding. Beneath the thick ice of Europa, in the vapor plumes on Enceladus, and within the methane lakes of Titan, astrobiologists are on the hunt for extraterrestrial life.

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We've honed in on these three moons because each is an 'ocean world,' an environment that contains a liquid ocean— and liquid can support the formation of life.

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Living organisms have to be able to grow, reproduce, and feed themselves, among other things. All of those functions require the formation of complex molecules from more basic components. Liquids such as water allow chemical compounds to remain in suspension instead of sinking under the force of gravity. This enables them to interact frequently in a 3-dimensional space and, in the right conditions, go through chemical reactions that lead to the formation of living matter.

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That alone isn't enough; the small but complex biomolecules that we're familiar with are sensitive to temperature— too hot or cold, and they won't mix. Liquid water has an additional advantage in that it's relatively temperature-stable, meaning it can insulate molecules against large shifts in heat. On Earth, these and other conditions in aquatic environments may have supported the emergence of life billions of years ago. Tantalizingly, the same could be true in other parts of our solar system, like these three icy moons.

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Europa, which is a moon of Jupiter, is probably the most intriguing ocean world. Beneath a surface layer of ice thicker than Mount Everest, there exists a liquid ocean as much as 100 kilometers deep. Astrobiologists think this hidden ocean could harbor life. Thanks to the Galileo probe, we can deduce that its potential salt content is similar to that of some lakes on Earth. But most of its characteristics will be a mystery until we can explore it further.

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Like Jupiter, Saturn also has moons that might have the right conditions for life. For instance— Enceladus is a tiny ball of ice that's small enough to nestle within the surface area of the Gulf of Mexico. Similarly to Europa, it likely contains an ocean deep under the ice. But Enceladus also has geysers that frequently vent water vapor and tiny ice grains into space. Astrobiologists are curious about whether these geysers are connected to the ocean below. They hope to send a probe to test whether the geysers' plumes of vapor contain life-enabling material from that hidden sea.

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Although it's the best known substance for nurturing life, water isn't necessarily the only medium that can support living things. Take Titan, Saturn's largest moon, which has a thick nitrogen atmosphere containing methane and many other organic molecules. Its

clouds condense and rain onto Titan's surface, sustaining lakes and seas full of liquid methane. This compound's particular chemistry means it's not as supportive a medium as water. But, paired with the high quantities of organic material that also rain down from the sky, these bodies of liquid methane could possibly support unfamiliar life forms.

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So what might indicate that life exists on these or other worlds? If it is out there, astrobiologists speculate that it would be microscopic, comparable to the bacteria we have on earth. This would make it difficult to directly observe from a great distance, so astrobiologists seek clues called biosignatures. Those may be cells, fossils, or mineral traces left behind by living things. And finding any biosignatures will be challenging for many reasons. One of the biggest concerns is to make sure we sterilize our probes extremely thoroughly. Otherwise we could accidentally contaminate ocean worlds with Earth's own bacteria, which could destroy alien life.

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Titan, Enceladus, and Europa are just three of possibly many ocean worlds that we could explore. We already know of several other candidates in our solar system, including Jupiter's moons Callisto and Ganymede, Neptune's Triton, and even Pluto.

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If there's this much potential for life to exist in our own tiny solar system, what unimagined secrets might the rest of the universe contain?